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Assured Urban Operations

SPO is a systems office with a mandate to counter new and emerging threats. While other offices at DARPA may focus on a particular technology, or set of technologies, we at SPO are problem-oriented. Give us a problem, and we do whatever it takes to solve it.

Our advanced systems orientation also allows us to exploit unique synergies that only arise in a system context, and thus provide an overall functional capability that is otherwise impossible to achieve with a single technology push—the whole is greater than the sum of its parts.

From underground to outerspace, and all regimes in between, including ground, air, and more recently, near-space, we do whatever it takes to bring new real-world systems to bear to secure our nation.

The specific challenge, or array of challenges, we're addressing is assured urban operations. A few names will summon the picture: Fallujah, Nasiriah, Najaf, and Baghdad. Fighting in the urban jungle and winning the peace is the problem that we have to solve.

We're going to lay out a series of challenges and suggest the kinds of technological solutions we imagine. Some will be quite specific, some will be more general. Some of the technologies we'll be talking about are already in the process of development. Some are only notional. In fact, some may be pretty far out there. Whatever we lay out, our objective is not to be prescriptive. Our objective is to inspire. We're not putting these ideas out there to dictate solutions, but to spark ideas. We're here to hook up the technology push with the opportunity pull.

To do that we need your ideas. We're not invested in any one technology, any one possible answer. We're invested in finding THE answer to the challenges before us.

Let's start by considering several pressing threats facing our troops straight from the headlines:

A car is speeding down the road toward a check point. Our Soldiers have no good options left. Do they use deadly force against what may be non-hostile civilians, causing the deaths of innocents and the alienation of population as a whole? Or do they wait that split second or two, very possibly sacrificing their own lives and those they are protecting?

It's a lousy choice. But too often, lousy is the only kind of choice we have in urban operations today.

Think of the fight for Fallujah, where our Marines would advance through the streets to purposefully draw fire from the enemy because that's the only

way they could identify who was an enemy combatant and where he was located. It was either that, or let Fallujah remain a terrorist stronghold and staging area for the terrorists' murderous attacks.

That's a lousy choice.

When a rocket propelled grenade is fired at your Humvee, all you can do is duck and pray.

That's no choice at all. That's just lousy.

These are just a few examples, but what they highlight is our essential challenge: we have to get out of playing in end game mode. We need to identify and neutralize threats—whether they're IEDs, RPGs, chem-bio weapons or what-have-you—before they can be deployed, even before they materialize!

Being several steps ahead of the enemy means developing technologies and associated real-world CONOPS that will give us the same kind of dominance in the urban battle that we already enjoy on the open battlefield.

In the major combat phase of the war in Afghanistan, our advanced sensors combined with precision strike capabilities were so effective that the Taliban said it was like fighting "an infidel army perched up in the sky."

How do we achieve that kind of seeming omniscience in the urban landscape, which is many orders of magnitude more complex, where the enemy can hide in buildings, or underground tunnels, or meld in with the civilian population?

We have a few ideas, some are in development, some are what we call DARPA-hard. We believe it can be done. We even think we have some thoughts about how to get from here to there. In some cases, we have a much better grasp of the problem than

we do of the solution. That is why we're here. More important, it's why you are here.

So let me give you a brief overview hitting on some of the key challenges our program managers will be laying out.

Wayne Bryden, will talk about force multipliers that will enable us to counter low-tech terrorist weapons.

As you'll see, these are the kinds of problems that demand a system of systems approach drawing on many different specializations, from engineering to materials science, to chemistry and biology. He'll be talking about:

- Reversible barriers that keep the bad guys out, but allow good guys to move in and out of secure areas at will.
- Traction control that improves on an initial development we call Polymer Snow, that will enable us to more finely control the movement of suspicious vehicles.
- Blast-free weapons that will breach buildings without posing a danger to non-combatants who might be present, and without the sometimes fatal time-lag between when our troops blow a door down and take down the enemy.
- Taggant materials that will indicate enemy activity within a building, and a system of taggants, stand-off spectroscopic sensors and distributed point sensors that will enable us to find explosives before they find us.

He'll be talking about ways to discriminate the motion of vehicles heavily laden with explosives, and ways to cordon off, and destroy explosive caches, possibly with biological agents that degrade them over time .

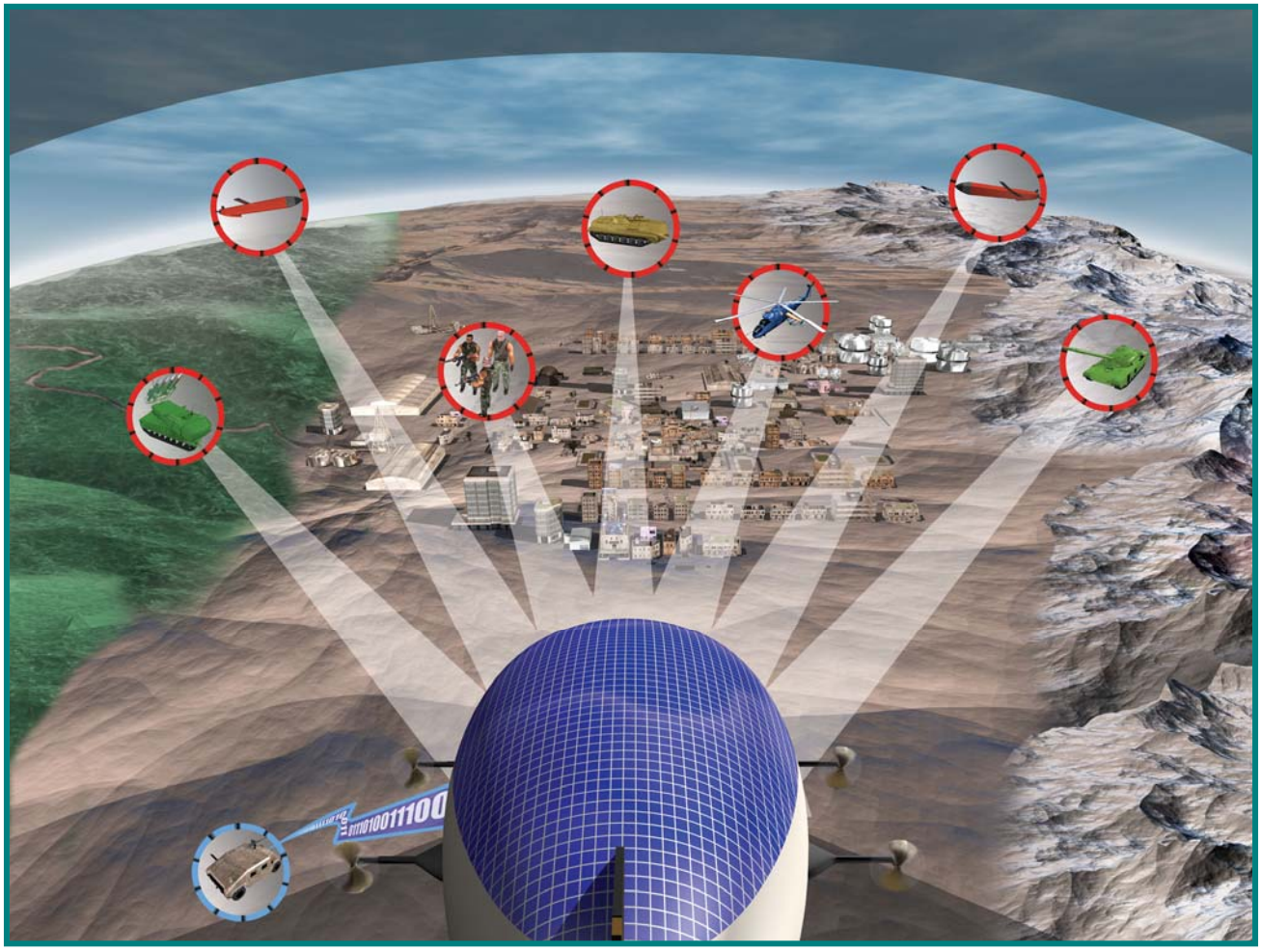
One of the sub-themes to this and the other presentations that we should all keep in mind is cost. Cost, of course, will vary according to many factors, including the technologies involved and the criticality of the need they address. The enabling technologies we pursue cannot impose undue

burdens on the supply chain or on the budget. Cost isn't the only factor, but it sure is one of the important ones.

Tim Clark and Ed Baranoski will talk about tailored tactical surveillance in the immensely challenging environment of the urban landscape.

To counter mortar fire, Tim will be proposing proliferated, widely distributed sensors—which, by necessity must be inexpensive. These would be mounted in high areas on the tops of buildings or towers, with the resolution and algorithms that will enable us to fix a one meter launch position within 1 second of flight.

For tracking ground movement, Tim will be talking about exploiting the potential of near-space, where sensors built into a zero-buoyancy stratospheric airship can give us the continuous surveillance of a geosynchronous satellite. Instead of orbiting some 22,000 miles above the equator, however, these airships would remain in place only 60,000 to 100,000 feet above the area being observed—allowing up close and personal resolution. Last year, SPO began in earnest the development of a highly integrated airship hyphen radar which we call ISIS for "Integrated Sensor is the Airship." We recognized that we could not conquer the challenges of zero buoyancy and meaningful payload capacity by following the traditional platform and payload integration methods. Instead, we conceived of entirely new designs of extremely lightweight electronics and materials that are so tightly integrated that one can no longer clearly delineate structure from sensor—hence the name ISIS. We are ready to go even further and begin creating responsive near-space systems, so that we can get the requisite urban surveillance persistence when and where we need within hours, if not minutes.



Still, there's the problem of all those buildings getting in the way. So Ed Baranoski will be talking about RF and radar multipath as a way to see around and even inside those buildings. Creating the algorithms that will enable us to unravel the multipath reflections off buildings will be beyond hard, but we believe it is achievable.

Of course, the enemy constantly adapts, and as our sensors and precision targeting have become ever more lethal, he has increasingly moved underground.

Larger underground facilities have more easily observable signatures from such things as power and ventilation. But what about urban tunnels, either pre-existing subways and sewers, or small made-to-order tunnels designed to hide the enemy's movement? Greg Duckworth will be detailing different ways we can detect these tunnels, including statistical correlations of human activity, seismic wave scattering and tomography, electromagnetic techniques, gravity gradiometers that can detect an empty space beneath the surface, and hyper-spectral imaging over time that can pick up vapor anomalies due to atmospheric pressure forcing at the entrances and exits, or simply leak points.

The key challenges will be the algorithms that allow us to separate out background clutter, and platforms and sensors that can cover wide areas at a time.

Finally, Tom McCreery will be talking about ways to counter chemical and biological threats, including nanotechnology that can seal and restore buildings, improved techniques to collect and detect biological threats, and the special challenge of protein toxins that can regain toxicity even after decontamination. He'll also be discussing ways to improve on our deep bleeder acoustic coagulation program with IVs that can be self-administered, and possibly fibers that can follow the acoustic signature of internal wounds, worm their way inside, and deliver lifesaving fluid.

So as challenges go, we've got what I think you'll agree is a content rich series of presentations in store. They cover the gamut, seeking to advance the cutting edge of science, medicine and engineering in almost every field imaginable. In case that's not enough, I'd like to briefly bring up two more challenges.

One is the problem of navigating in urban environments without GPS. DARPA already has a GPX program to deal with GPS jamming. This year we successfully demonstrated a full navigation system, using airborne transmitters to replace the signals coming from distant satellites. We'd like to take this a few steps further.

An even more difficult challenge is navigating inside buildings, or underground in caves and tunnels. Here we are exploring a number of approaches including bringing in beacons powerful enough to penetrate earth, rubble and buildings as well as exploiting the physics of the natural environment to accurately pinpoint our location? Perhaps we could sense and exploit the gravity signals of the tidal pulls of the Sun and Moon, the naturally occurring anomalies in the Earth's magnetic filed, or other, more penetrating, influences.

Some of our challenges are pretty far out there, but it's an area we want to explore with your help.

Finally, we should discuss something as fundamental as bricks and mortar, providing the basic infrastructure that supports daily urban life.

A lot of us may not have thought of this as a critical military function—before Iraq, that is, but as Major General Peter Chiarelli has pointed out, the breakdown in basic infrastructure such as water, sewage and electricity, has created a climate of disaffection in the population and a breeding ground for the recruitment of terrorists.

Our military and civilian contractors, all of whom risk their lives everyday in Iraq, have done an extraordinary job rebuilding that country after decades of Sadamite tyranny and decay, even while

terrorists target them and try to blow up the facilities they are so diligently working to restore.

But, as Chiarelli has said, you can't first provide security and then rebuild infrastructure—you have to do both at the same time.

My final challenge to you here today is: can we find technological short cuts, new materials, new construction methods, new ways of thinking about infrastructure that would shorten the process and vastly relieve the supply burden?

Would it be possible to develop a smart, decentralized, and distributed power generator system? Like the Internet, this power Internet, or "Pi-NET" for short, would enable power to be gradually brought online by a number of distributed smart yet heterogeneous, generators that obey certain Pi-NET protocols and standards (like TCP/IP for the Internet), thereby avoiding the enormous difficulty of bringing back a single major power station plugged into a single major power grid.

There are potentially many other ideas like this. We need only use our imaginations.